Steep Cut Slope Composting:
Field Trials and Evaluation

by

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A proposal prepared for the

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November 24, 2008

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PROBLEM STATEMENT

Successful revegetation of highway right-of-ways following construction, reconstruction, and other disturbances of Montana Department of Transportation (MDT) lands requires creating environmental conditions conducive to the successful establishment and survival of reclamation plantings. Steep cut slopes present a challenge, given the difficulty to place salvaged soil with conventional equipment and retain soil on these areas. Standard practice is to hydromulch and broadcast seed; however, this is problematic on steep bare slopes, often resulting in marginal plant establishment related to low germination rates and seedling survival due to nutrient poor, rocky substrates characteristic of cut slopes. Poor vegetation establishment leads to increased erosion and sedimentation, occasional slope failure, and increased noxious weed growth. Unsuccessful revegetation has the potential to substantially increase maintenance costs in these areas.

Roadside composting research done for MDT by the Research Reclamation Unit at Montana State University (MSU RRU 2007) established baseline compost application rates MDT uses to guide reclaiming steep slopes. The research used high compost application rates. New research is needed to optimize application rates using various compost materials and application techniques and increase the performance using less compost on steep slopes. Past research observed loss of applied surface compost from wind erosion prior to vegetation establishment. Compost stabilization techniques limiting wind erosion are required prior to widespread adoption of compost application on MDT steep cut slopes.

BACKGROUND SUMMARY

The purpose of this project is to expand the knowledge base developed from roadside composting research completed in 2003 and 2007 by the Reclamation Research Unit at Montana State University for MDT. That project, titled *Evaluation of Organic Matter Addition and Incorporation on Steep Cut Slopes*, established baseline compost application rates MDT uses to guide reclaiming steep slopes.

The 2003 research served two purposes:

- A literature review was conducted to synthesize available examples of compost application and incorporation on steep cut slopes to stimulate vegetation growth and retard erosion.
- The report identified equipment capable of applying or incorporating compost on slopes steeper than 3 horizontal to 1 vertical (3H:1V).

The 2007 research demonstrated the value of applying compost to reduce harsh growing conditions on steep cut slopes. Increased vegetation establishment, high survivability, and decreased soil erosion were observed on all compost treated plots.

The 2007 research project applied compost at application rates of 1 and 2 inches thick. Study results failed to show a difference in vegetation performance and erosion control between the 1 and 2 inch application rates.

Even though a measurable benefit can result from less compost applied to hostile soils on steep cut slopes, there is a need to develop a matrix to assist MDT in setting more research-based application rates. In addition, there is a need for better methods to retain compost and seed on steep cut slopes.

BENEFITS

Results and analyses of this project will allow MDT to make more informed decisions regarding effective revegetation and stabilization of steep cut slopes. Specifically,

- biologically effective reclamation methods for steep cut slopes will be identified, tested, and described;
- cost effective application rates of compost will be identified, including evaluation of multiple rates; and
- promising methods to retain compost on steep slopes will be identified and described.

RESEARCH PLAN

This research project has two primary objectives:

- Evaluating compost performance applied at rates less than the 1 to 2 inches. This phase of the research will establish minimum quantity recommendations to be used on steep cut slopes.
- Evaluating the use of various materials and/or application techniques to prolong the period of time the compost remains on steep slopes.

Task A: Kickoff Meeting:

The MDT Technical Panel including the MDT Reclamation Specialist will review the work plan, approve the location of the potential test site, and narrow the selection of potential compost application and retention techniques. A schedule will be developed to coordinate test site seeding with appropriate mixtures by MDT and subsequent compost application and implementation of retention strategies by the Western Transportation Institute and the Reclamation Research Group (WTI-RRG).

Task B: Test Site Selection and Location

A test site has been identified approximately 15 miles west of Bozeman on Montana Highway 84 (Figure 1). This lane widening road project was completed in 2002. Steep slopes were cut in a Tertiary-age valley fill soil type. The slopes were not soiled before seeding. In 2008 these slopes were nearly devoid of vegetation (Figure 2). In this location Highway 84 trends east-west providing the opportunity for establishment of treatment plots on both north-facing and south-facing slopes. Cut slopes are approximately 2H:1V. Slope length is approximately 12.19-18.29 meters (40-60 feet). Test plots would be constructed from the top to the toe of the slope. Test plots would be 92.9-185.8 square meters (m^2) or 1,000-2,000 square feet (ft^2).

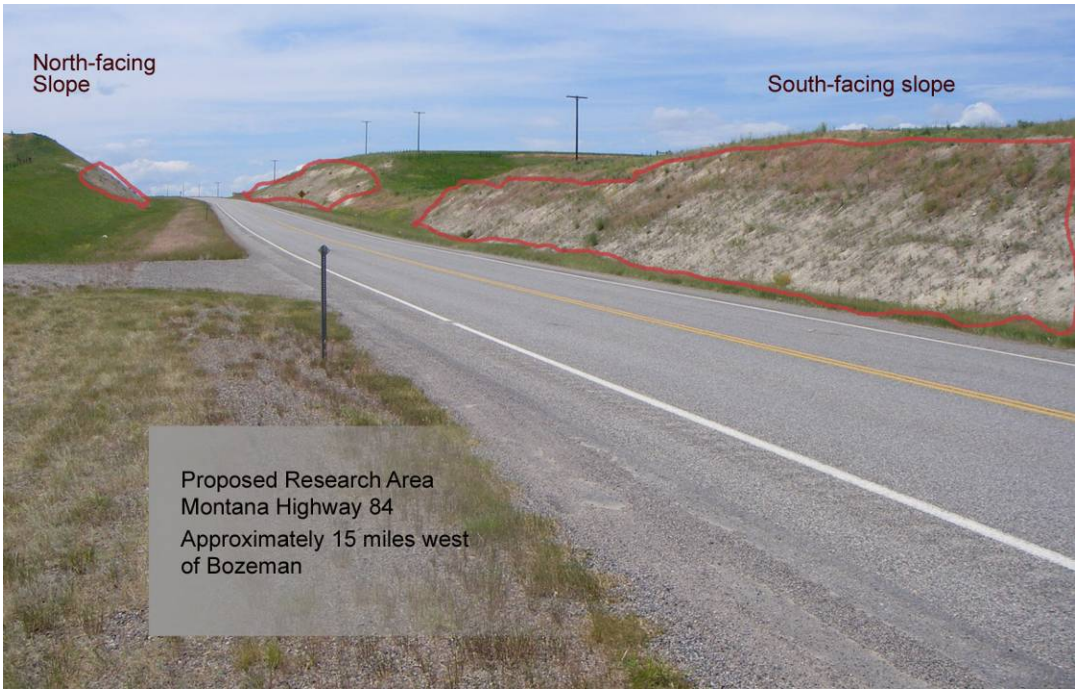

Figure 1: Poorly vegetated steep cut slopes on Montana Highway 84 proposed for test site.

Figure 2: Sparse vegetation is evident on the slopes selected for establishment of research plots. Gullies have begun to establish where stabilizing vegetation is absent.

Task C: Test Plot Construction

Construction of test plots includes the following steps:

- Seeding and compost applications.
- Stabilization and retention materials and their applications.

Test plot construction will be implemented in Fall 2008 subject to contracting, availability of the implementation subcontractor, and availability of materials. The goal is to prepare the site, and implement experimental treatments before winter weather. A dormant fall seeding will be performed to allow Spring 2009 germination. Plots will be measured, staked, and photographed prior to implementation. Roadway safety and flagging is the responsibility of MDT. No re-grading and mechanized work on-slope is anticipated. The width of the roadway right-of-way is sufficient to allow on-slope implementation without interfering with traffic. Storm water run-off Best Management Practices (BMPs) will be installed even though the ditch is well vegetated and the experimental treatments should only serve to improve storm water control. No work will be performed outside the right-of-way.

An experimental design has been developed to address issues identified in the request for proposal (RFP), supplemented by a comparison of vegetation development on north-facing and south-facing slopes (Table 1).

Table 1: Experimental design for compost research plots on Montana 84.

Treatment	Equipment		Aspect	Number of Plots				Total
	Blower Truck	Hydromulch Truck		Compost Application Rate				
				0	1/8 " (0.32 cm)	1/4" (0.64 cm)	1/2" (1.3 cm)	
Control	No	No	South	2	0	0	0	2
Control	No	No	North	1	0	0	0	1
Compost blanket	Yes	No	South	0	2	2	2	6
Compost blanket	Yes	No	North	0	1	1	1	3
Compost blanket plus tackifier A (guar based)	Yes	Yes	South	0	0	0	2	2
Compost blanket plus tackifier B (dirt glue)	Yes	Yes	South	0	0	0	2	2
Compost blanket plus tackifier C (synthetic)	Yes	Yes	South	0	0	0	2	2
Compost blanket plus erosion control fabric	Yes	No	South	0	0	0	2	2
Compost blanket plus netting	Yes	No	South	0	0	0	2	2
Total Number of Plots				**3**	**3**	**3**	**13**	**22**

Application Rates	*Volume*			
Application Rate per 1000 square feet: ft^3 (m^3)	0.0	10.4 (3)	20.8 (5.9)	41.7 (11.9)
Application Rate per 1000 square yards: yd^3 (m^3)	0.0	0.4 (0.3)	0.8 (0.6)	1.5 (1.1)

Sensitivity Analysis	*Compost Volume Required: yd^3 (m^3)*			
Assume 1000 square foot (929 m^2) test plots	0.0	1.2 (.92)	2.3 (1.8)	20.1 (15.4)
Assume 1500 square foot (1393 m^2)test plots	0.0	1.7 (1.3)	3.5 (2.7)	30 (23)
Assume 2000 square foot (1858 m^2) test plots	0.0	2.4 (1.8)	4.6 (3.5)	40.1 (30.7)

Compost will not be incorporated into the soil. In the RFP, two replications were requested for the comparison between the 1/2-inch (0.635 cm.) thick compost blanket and the stabilization treatments. The compost application is proposed using a blower truck, plus two variations using a hydromulch truck to apply tackifier. A total of 22 research plots are proposed, including four plots on the north-facing and 18 on the south-facing slopes. Two control plots without compost will be built on the north-facing and one on the south-facing slopes. The control plots will be seeded. Two compost blanket plots will be constructed for each application rate (1/8-, 1/4- and 1/2-inch or 0.318, 0.635, and 1.27 cm., respectively), with additional stabilization. The compost

stabilization techniques proposed include two replications of the 1/2-inch (0.635 cm.) compost blanket with the following four treatments:

- Compost blanket plus tackifier A: A compost blanket will be applied followed by application of a binding tackifier such as Dirt Glue. Selection of the tackifier will be finalized based on discussion with the MDT Reclamation Specialist and the implementation subcontractor.
- Microblend compost plus tackifier A: A special compost formulation (give size of compost) will be requested from a commercial compost provider to include additional screening to remove compost that cannot be applied using a hydromulch truck. Tackifier will be added to the fine compost product and surface applied. This approach is identical to a Beartooth Highway demonstration by MDT in 2005 (see http://www.kiewit.com/markets/pro_beartooth.html) on a steep south-facing rock cut (P. Johnson, pers. comm.).
- Compost blanket plus fabric: A compost blanket will be surface applied and subsequently covered with a MDT-approved erosion control fabric.
- Compost blanket plus tackifier B: Wind erosion of dried compost is a central problem associated with compost blankets. A stabilization treatment is proposed using a second less expensive tackifier product (L. Read, pers. comm.). Selection of the tackifier will be finalized based on discussion with the MDT Reclamation Specialist and the implementation subcontractor.

The seed mix used on the research plots will be provided by MDT.

Task D: Data Collection and Analyses

Data collection objectives include assessing vegetation establishment, soil erosion, and the stability of the compost blankets. Vegetation will be monitored once during the first growing season (2009) and twice during the second growing season (2010). Vegetation monitoring will estimate seedling emergence and density during the first growing season and will report stems per unit area by life form/morphological class (i.e., perennial grasses, perennial forbs, annual grasses, annual forbs, and shrubs). Data collected for vegetation classes will identify whether plants are native or introduced species. Plant cover will be estimated if sufficient plant growth occurs during the first growing season. During the second growing season, vegetation monitoring will include plant cover by life form/morphological class in the spring monitoring event and plant cover by life form/morphological class plus vegetative reproduction during the fall monitoring event. In addition, all noxious weeds will be recorded.

Species identification will be included for the three to five species with the highest stems/unit area for the first year and if sufficient plant growth occurs, for the three to five species with the highest plant cover in the first year. In the second year, the three to five species with the highest plant cover will be identified.

Measurement of erosion will be qualitatively estimated using the BLM method for Montana (Clark 1980). This is the same method used in the earlier compost research for MDT (MSU RRU 2007). The erosion assessment method uses a numeric scoring system to estimate the frequency and distribution of rilling, gullying, surface soil movement, pedestalling, litter

movement, and presence of surface flow patterns. Erosion monitoring will occur at the same time as vegetation monitoring unless rainfall conditions in the Bozeman area allow for opportunistic monitoring in response to weather events.

Assessment of compost stabilization methods will be performed qualitatively and documented using digital photographs and measurements of areas denuded of compost by wind action. The research sites are located in a windy area and their location is made more severe by the funneling effect of the deep road cut. Compost stability will be monitored at the same frequency as vegetation and supplemented by opportunistic monitoring following severe wind events.

Task E: Reporting

Quarterly progress reports will be submitted by WTI-RRG per standard contractual requirements of MDT. A test plot construction narrative will be prepared in December 2008 following implementation in Fall 2008. The first year monitoring report will be prepared in December 2009. A draft final report will be prepared in November 2010 and a final report in December 2010. After the completion of the final report, upon request, a project summary report will be generated for MDT. In addition, upon request, a final presentation of the findings will be given to MDT by the co-principal investigators.

DELIVERABLES

The project will include a field season to construct the test plots in Fall 2008 and two field seasons to measure the effectiveness of compost retention and the quality and quantity of the establishment of vegetation on the steep cut slopes. WTI-RRG will provide research results in reports and a potential presentation:

- Test Plot Construction Report will detail and summarize all work completed on test plot construction and will be submitted by January 1, 2009.
- 2009 Field Season Report will present findings from vegetation and soil erosion data collected and include assessments of compost stabilization techniques and will be submitted by January 1, 2010.
- Final Report will summarize all information presented in previous reports, as well as vegetation and erosion data collected and assessments of compost stabilization techniques from the 2010 field season. It will include photos of all test sites. Final recommendations for compost application rates and preferred stabilization techniques are to be made based upon vegetation performance, erosion analyses, cost benefit analysis, and constructability issues. The final report will be submitted by January 1, 2011.
- Project Summary Report will be written if requested by MDT.
- Final presentation on the findings and recommendations will be given to MDT upon request.

IMPLEMENTATION

MDT will be able to use the results of the study to apply and retain compost on steep cut slope reclamation projects throughout the state so that revegetation efforts are maximized on 3H:1V and 2H:1V slopes. The results of the study will provide the MDT Reclamation Specialist with the most cost effective application rates of compost to apply on top of seedings as well as techniques that are best suited to retain compost on steep cut slopes.

SCHEDULE

Task	2008					2009						2010			
	O	N	D	A	M	J	J	A	D	A	M	J	J	A	D
Task A: Kickoff Meeting															
Task B: Test Site Selection and Location															
Task C: Test Plot Construction															
Task D: Data Collection and Analyses															
Task E: Reporting															

STAFFING

Robert Ament, WTI

Robert Ament, M.S., Biological Sciences, is the Road Ecology Program Manager at the Western Transportation Institute at Montana State University. He has more than 25 years of experience in field ecology, natural resource management, environmental policy, and organizational development. He manages over 20 active road ecology research projects throughout the western United States and currently serves on five national or international committees/boards of directors. His expertise is in plant ecology, where he has 10 field seasons in conducting vegetation studies in Montana, Idaho, Oregon, Alaska, and Utah.

Stuart Jennings, RRG

Stuart Jennings, M.S., Land Rehabilitation, is a Principal and Scientist with the Reclamation Research Group, LLC based in Bozeman. He formerly was employed by Montana State University, Reclamation Research Unit as a Research Scientist. He has 20 years of experience in disturbed land revegetation, soil geochemical analysis, native grassland reestablishment, and storm water control on large scale disturbances in Montana and the western United States caused by mining and transportation corridor development. He is a project manager on several projects with emphasis on soil bioengineering for vegetation development for Federal and State agencies. He was the Principal Investigator on the earlier research performed for MDT by MSU.

The level of effort for various project personnel is summarized by task in Table 2.

Table 2: Person hours devoted to each task.

		Task					
Name	Role in study	Kickoff Meeting	Test Site Selection and Location	Test Plot Construction	Data Collection and Analyses	Reporting	Project Management
Rob Ament	Principal Investigator	16	24	40	60	120	20
Stuart Jennings	Principal Investigator	16	40	40	60	120	20
Research Technician	Data collection	0	0	30	120	40	0
Communications staff	Report preparation	0	0	0	0	24	0
Support staff	Administration	0	4	8	8	0	0
	Total	**32**	**68**	**118**	**248**	**304**	**40**

PROJECT BUDGET

AMENDED Budget 11/7/08		WTI Team			Other Direct Expenses				Totals
Steep Cut Slope Composting		Rob Ament, WTI	Tech./Admin. Support	Total Hours/Total Costs	Travel	Minor Equipment (<5000)	Plot Construction Contract	Subcontract: RRG	Total Costs
Task #	**Task Title**	$49.25	$28.00						
A		16		16					
	Kickoff Meeting	$788.00	$0.00	$788.00	$ 200.00			$ 1,531.00	$2,519.00
B		24	4	28					
	Test Site Selection and Location	$1,182.00	$112.00	$1,294.00	$ 150.00			$ 4,228.40	$5,672.40
C		40	8	48					
	Test Plot Construction	$1,970.00	$224.00	$2,194.00	$ 150.00	$ 200.00	$ 19,675.00	$ 6,259.00	$28,478.00
D		60	8	68					
	Data Collection and Analyses	$2,955.00	$224.00	$3,179.00	$ 200.00	$ 200.00		$ 18,220.00	$21,799.00
E		140	24	164					
	Reporting	$6,895.00	$672.00	$7,567.00				$ 16,221.00	$23,788.00
	TOTAL HOURS	280	44	324					
	TOTAL DIRECT COSTS (includes ben.)	$13,790.00	$1,232.00	$15,022.00	$ 700.00	$ 400.00	$ 19,675.00	$ 46,459.40	$82,256.40
0.2	Indirect Costs at 20%	$2,758.00	$246.40	$3,004.40	$140.00	$80.00	$0.00	$5,000.00	$8,224.40
	Total Project Costs	$16,548.00	$1,478.40	$18,026.40	$ 840.00	$ 480.00	$ 19,675.00	$ 51,459.40	$90,480.80

REFERENCES

Clark, R. 1980. Erosion Condition Classification System. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. Technical Note #346.

Johnson, Phil. (Reclamation Specialist, Montana Department of Transportation) in discussion with the authors, October, 2008.

Montana State University, Reclamation Research Unit. 2007. Evaluation of Organic Matter Addition and Incorporation on Steep Cut Slopes, Phase II Test Plot Construction and Monitoring. MDT Research Division, Technical Report, Helena, MT.

Read, Lisa. (President, Quality Landscape Seeding, Inc.) in discussion with the authors, October, 2008.